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ABSTRACT

The ultimate goal of this project is to improve student accuracy in hearing the several interval sounds, with the subsequent hope of improving perception of the pitch factor in music. The data for this first phase include the administration of aural skills tests to 160 University of Iowa students in the fall of 1976, to the 142 subjects continuing in the spring of 1977, and to 165 students from five other schools in the spring of 1977. The following observations may be of some interest and can be thought of as hinting at a few interval hearing characteristics of the general music population of students: intervals vary in difficulty in the performance modes, but some general tendencies are apparent; confusion patterns are also evident; and individual intervals are important in particular performance modes. It is thought that some listing of quintile levels and likely confusion problems could serve as guidelines for providing remedial training. A final hope is that this project will inspire more work in this and related areas concerning pitch perception to be accomplished with the final goal of improving student achievement. (VT)

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A PROJECT IN AURAL INTERVAL IDENTIFICATION, PHASE ONE

by

Marvin S. Thostenson

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A PROJECT IN AURAL INTERVAL IDENTIFICATION, PHASE ONE

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Marvin S. Thostenson

Most musicians will agree that a thorough knowledge of intervals is an important facet of training for music students. This project deals with one aspect, the aural identification of intervals by a sample that totals 613 students. The data for this first phase includes the administration of the aural skills tests to 160 University of Iowa students in the fall of 1976, to the 142 continuing in the spring of 1977 and to 165 students from five other schools in the spring of 1977. For some details data from two earlier University of Iowa classes with 146 students is used.

I. Background Information.

Musical pitch divides into octaves that divide into 12 half-steps. These combine to form 12 discrete sound distances called intervals. Each one can be identified by its symbol-name, such as minor second (m2), or it can be written in music notation, given one note. In this project each interval heard is identified by symbol-name. Aural identification is necessary in three performance modes, namely, upward, downward and simultaneous.

Errors in identifying intervals occur for several reasons. A student may have developed an incorrect association between an interval sound and its symbol-name. A distraction such as thinking about the last item heard may have persisted to fog the memory, or, the student may not yet have any distinct aural interval image in his memory. The result is that an interval is incorrectly identified using another interval's name, thus causing a confusion. There are 132 such confusions possible using only the basic major, minor, perfect and tritone interval names. Lack of previous systematic training in this area is obvious with a rather large proportion of music

students, especially in the first year, but hearing deficiencies continue to persist to lesser degrees in more advanced classes.

II. Purpose.

The ultimate goal of this project is to improve student accuracy in hearing the several interval sounds, with the subsequent hope of improving perception of the pitch factor in music. Correlative is the goal of completing the basic aural interval training more quickly, ultimately, perhaps, in one semester. This would permit a broader development of musicality during the four semester sequence normally allotted to aural skills programs.

The above mentioned goals have a logical chance of becoming possible through the development of a systematic, efficient and reliable methodology for improving the aural perception of intervals. It seems reasonable to accomplish this by utilizing the results of research to devise carefully constructed remedial training procedures or programs to lessen the number of errors usually involved in the most error-prone confusions. Studies of this type are ideally suited to the capabilities available in computer assisted instruction. The present project does not include data from any school that was then benefitting from the use of C.A.I., but some comparisons are made with the results achieved by one small sample that was intensively tested in their identification of aural intervals and triads.[1] A final hope is that the information made available in this project may possibly provide some impetus for further research in this area, both through and independent of C.A.I. facilities.

III. Brief Review of Selected Research.

There has been considerable research in the area of pitch, especially as related to the measurement of achievement and also the estimation of musical talent. However, that dealing directly with the perception of intervals is

limited, although a number of studies touch on the topic tangentially. One who developed a useful interval discrimination test, Madison (1942)[2], sets the proper philosophical tone by stating that "interval quality lies at the very root of our system of tonality or of atonality for that matter." In his tests each item is constructed in a four-foil multiple-choice format, in which the student hears four intervals played. The correct response is to hear which of the four sounded intervals sounds unique; the other three are a single contrasting interval heard at three different pitch levels. Ortmann(1934)[3], Lundin(1949)[4] and Ottman(1956)[5] were able to show that significant relationships exist between interval perception and the aural music skills of sight singing and music dictation. Hutton, Barnes and Bolden have done research in methodology involving the pitch factor. Hutton (1953)[6] found that use of a flash card technique for drilling pitch patterns raised the sight singing scores of selected fourth grade pupils. Barnes (1960)[7] showed that interval hearing was important, but also noted that contextual influence was an inhibiting factor requiring consideration in teaching sight singing. Bolden (1967)[8] compared three methods for improving sight singing and concluded that none among extensive class use of the piano keyboard, the recorder, syllables, or letter names was significantly better. However, the use of either syllable or letter names yielded somewhat higher scores in the pitch area. Three other researchers, Ritchie, Marquis, and Cooper, discussed the effect of context upon perception and performance of the interval content of melodic examples. Ritchie (1960)[9] found that the harmonic content of a phrase often inhibited the recognition of melodic pitches, except when the harmonic structure agreed with the melodic line in an obvious manner. In comparing the singing of isolated intervals with intervals within a melodic context Marquis (1963)[10] found that rhythmic position, scale position, and the

harmonic implications were considerations affecting the perception and performance of melodic intervals. Cooper (1965)[11] built a sight singing test that revealed differing levels of difficulty for intervals occurring in the various contextual situations found in his test.

A recent project, that of Killam, Lorton and Schubert (1975)[1], is quite directly applicable to the present project. This study dealt intensively with a sample of 15 students using the C.A.I. facilities at Stanford University. Several points from this study provide interesting comparisons with the present study.

IV. Testing and Analysis -- University of Iowa Samples

Three different tests were used primarily in this project, namely, Tests #3, #4, and #5. To a lesser extent information derived from use of two earlier tests (#1 and #2) was of value. Each test had a separate section for each performance mode -- upward, downward, and simultaneous. The 108 items were comprised of three 36-item sections, each one including three examples of each basic interval, namely, the m2, M2, m3, M3, P4, tt, P5, m6, M6, m7, M7, and P8. Tests #2 and #4 had only one example of each interval, giving them three sections of 12 items each. All the tests utilized selected pitches from the F just below the bass clef to the D above the second ledger line above the treble clef. This gamut of three octaves and a major sixth falls well within the vocal range. The above information is presented in more detail in Table I on the following page.

The data provided by the three 1976-1977 first-year samples using Tests #3, #4, and #5 was analyzed to reveal the interval errors and the accompanying confusions generated. This brought out that 40 upward, 49 downward, and 55 simultaneous interval confusions accumulated enough errors to be considered significant. Significance for this project was determined in a practical manner. Each sample was tallied by scores from high to low and then the

Table I

Interval Testing, University of Iowa Samples

Sample	Size	When Tested	Test	Upward	Downward	Simult's	Total Sample
1st yr.	85	Fall,1974	#1	36 items	36 items	36 items	108 items
1st yr	61	Spring,1976	#2	12 items	12 items	12 items	36 items
1st yr.	95	Fall,1976	#3	36 items	36 items	36 items	108 items
1st yr.	83	Dec.,1976	#4	12 items	12 items	12 items	36 items
1st yr.	80	Spring,1977	#5	36 items	36 items	36 items	108 items
2nd yr.	65	Fall,1976	#3	36 items	36 items	36 items	108 items
2nd yr.	65	Dec.,1976	#4	12 items	12 items	12 items	36 items
2nd yr.	65	Spring,1976	#5	36 items	36 items	36 items	108 items

the papers were divided into five equal or nearly equal quintile sections -- top, upper middle, middle, lower middle, and low. Thus, in a class of 75 to 100 pupils (or in such a grouping) each quintile would contain from 15 to 20 papers representing that number of students. Interval confusions with but one or two errors were considered to be random but a cluster of 3 or more errors was considered significant since it suggested an error level of about 15 to 20% at any particular quintile level. The number of confusions, significant or otherwise, and the associated errors in each mode are shown in Table II. These results derive from the first year sample shown to be taking Tests #3, #4, and #5 in Table I, above.

Table II

Interval Tests, 1st yr., SUI, Errors and Confusions

Mode used	Total errors	Total conf's	Signif. errors	Signif. conf's	% of total error included
upward	633	64	576	40	91.0 %
downward	879	88	795	49	90.4 %
simult's	962	102	833	55	86.7 %
Totals	2474	144	2204	144	89.1 %

The total of 252 confusions of which 144 were significant included 82

separate confusions from the 132 possible. Among these 82 twelve pairs were significant in both directions, thus setting apart a set of 24 confusions that were common to all three modes of performance. These 24 interval confusions represented only 29.3% of the 82 different confusions but accounted for 53.3% of all the errors made in the three modes of performance (1323 errors of the total of 2474). See the listing in Table III.

Table III.

Twelve Double Pairs of Interval Confusions

Double Pairs	One confusion *	Another confusion *
m2; M2	m2/M2	M2/m2
m3; M3	m3/M3	M3/m3
P4; P5	P4/P5	P5/P4
tt; m3	tt/m3	m3/tt
tt; m7	tt/m7	m7/tt
P5; M3	P5/M3	M3/P5
m6; M6	m6/M6	M6/m6
m7; M7	m7/M7	M7/m7
P8; P5	P8/P5	P5/P8
P4; m3	P4/m3	m3/P4
m6; m7	m6/m7	m7/m6
M7; tt	M7/tt	tt/M7

* m2/M2 is read as "A minor 2nd is heard as a major 2nd", etc.

The remainder of the confusions encountered were classified in three ways. For each mode of performance several more two-way interval pairs were found to be significant in relation to at least one but never all three modes. Another group of confusions significant only in one direction were likewise significant to at least one mode of performance. The last group consisted of the confusions and errors considered to be non-significant.

V. Statistics -- University of Iowa, First and Second Year Samples

The statistical data for the SUI first-year class on Tests #3-#5 are shown in Table IV. Even though the median in each performance mode is 30 or higher, there was much wider dispersion in the low one-half of the scores

resulting in high reliability in each section. In the short test, #4, only the simultaneous section of 12 items gave evidence of reliability (and conversely deficiency in their auditory recognition). However, it becomes obvious at the end of the second semester that only upward intervals have been well learned as one notes by examining the data for Test #5.

Table IV.

Statistical Data, SUI, 1st-yr., Fall '76, Dec., '76, Spring '77

Class	N	Mode	Items	Median	Mean	St.Dev.	Rel'y
Fall 1976, 1st yr.	95	up	36, Test #3	32.12	29.97	7.45	.96
		down	36, Test #3	31.66	29.09	8.96	.95
		sim's	36, Test #3	30.00	28.52	10.50	.96
Dec. 1976, 1st yr.	83	up	12, Test #4	12.00	11.23	1.64	-----
		down	12, Test #4	11.00	10.78	2.80	-----
		sim's	12, Test #4	10.97	9.70	2.74	.80
Spring 1977, 1st yr.	80	up	36, Test #5	34.32	33.21	3.5	.66
		down	36, Test #5	33.50	31.22	5.9	.88
		sim's	36, Test #5	31.2	31.6	6.4	.91

Since first year students are prone to make the most errors in aural interval identification it was felt wise to check first and second year data as to statistics, interval errors and interval confusions. The second year class took the same series of three interval tests (#3, #4, and #5) but under less favorable circumstances. The first long test, #3, was given during the first two weeks of the semester, thus relying heavily on the training recieved during the previous year. After this first testing almost no class time was given to interval identification as such, but low scoring students were encouraged to do work in the Aural Skills Laboratory (using ordinary taped

practice materials). These factors may account in part for the small differences that exist in the comparative scores of the first and second year class. Only in the first upward interval test, #3 in the fall of 1976, is the difference in means actually significant. Since both classes included a number of high or perfect scores it follows that the differences that did exist quite likely resulted from (1) the attrition of some low scoring first-year students, and (2) the improvements made by a number of previously lower scoring students. The data for the SUI second year class is given in Table V, which will make it possible to compare the two classes.

Table V.

Statistical Data, SUI, 2nd yr., Fall '76, Dec., '76, Spring '77

Class	N	Mode	Items	Median	Mean	St.Dev.	Rel'y.
Fall 1976, 2nd yr.	65	up	36, Test #3	35.27	32.95	4.66	.91
		down	36, Test #3	33.36	31.14	6.10	.90
		sim's	36, Test #3	32.17	30.06	6.67	.91
Dec. 1976 2nd yr.	62	up	12, Test #4	12.00	11.37	1.32	-----
		down	12, Test #4	12.00	10.98	1.86	-----
		sim's	12, Test #4	12.00	10.18	2.21	-----
Spring 1977, 2nd yr.	63	up	36, Test #5	35.3	34.1	2.92	.74
		down	36, Test #5	34.5	32.6	4.93	.86
		sim's	36, Test #5	33.5	31.4	5.52	.88

VI. Confusion Analysis -- University of Iowa, First and Second Year Samples

Analysis of the data from the second year class showed that 72 confusions existed, of which 43 confusions involving 573 errors were yet significant at the end of the second year of training. As a matter of consistency it is noteworthy that 38 of these 43 significant confusions were included with the 54 confusions found significant in the first year sample and through this

commonality accounted for 553, or 96% of all the errors made. In the upward mode 21 significant confusions with 170 errors were found; of these 20 confusions including 167 errors were common with the set of 54 first year confusions, and thereby accounted for 96% of the upward errors. The 33 significant confusions of the downward mode included 30 common with the set of 54, covering 232 or 95% of all downward errors. The simultaneous mode included 18 confusions, all of which were common with the set of 54 and therefore accounted for all the simultaneous errors.

In as much as the set of 54 first year confusions includes all confusions that were significant at the first year level and that 38 of the 43 significant second year confusions representing 96% of the errors made are common with the 54 set suggests a strong persistence among these interval hearing confusions. It seems logical to infer that these 54 interval confusions exhibit a high degree of resistance to learning. Reducing the set of 54 to a more concentrated form, using eleven of the twelve two-way all-modes confusions (less the P4/M3 pair), three two-way selectively-modal confusions (tt/m6, M7/m6, and M6/P5) and two one-way confusions (m2/M7 and M2/M3) for a total of 30 basic confusions yields interesting results, as shown in Table VI.

Table VI.

Comparing Confusions and Errors: Sets of 54 and 30 Confusions

	12 two-way - all 3 modes	12 two-way - not 3 modes	6 one-way - not 3 modes	Set of 54 confusions	11 two-way - all 3 modes	3 two-way - not 3 modes	2 one-way - not 3 modes	Basic set of 30 confusions
Con's-	24	24	6	54	22	6	2	30
Err's-	2215	496	155	2866	2170	216	86	2472
% of 54 set -	100%	100%	100%	100%	96%	44%	55%	85%

The fact that the 30 most significant confusions account for 85% of the errors

and that conversely the other 24 confusions account for only 15% of all the errors is possibly worth remembering. Table VII gives a listing of both the Set of 54 and the Basic Set of 30.

Table VII.

Listing of the Set of 54 and the Set of 30 Confusions

	Set of 54	Set of 30
Twelve two-way confusions -		
-- 24 in "54" and 11 in "30" are problems in all performance modes. ---	M7/tt M7/m7 m6/m7 P5/P4 m3/M3 tt/m7 m6/M6 m2/M2 P5/M3 P8/P5 tt/m3 P4/M3	M7/tt M7/m7 m6/m7 P5/P4 m3/M3 tt/m7 m6/M6 m2/M2 P5/M3 P8/P5 tt/m3
-- 24 in "54" and 3 in "30" are problems in certain perf'e modes. ----	tt/m6 M7/m6 M6/P5 m6/P5 M6/m3 m6/M3 M6/M7 M6/m7 M6/M3 m6/m3 tt/P4 P4/m3	tt/m6 M7/m6 M6/P5
Six one-way confusions -		
-- 6 in "54" and 2 in "30" are problems in certain perf'e modes. -----	m6/P4 M6/tt tt/P5 M2/m3 M2/M3 m3/P5	m6/P4 tt/P5

VII. Statistical Data -- Other Schools

Each of the five other schools cooperating in this project gave one test to their students, Test #5 consisting of 108 items with 36 intervals in each of the three performance modes. It can be assumed that the test administration was similar for all schools involved since all taking part followed the same instructions (as reviewed previously). Since the number of students involved is 165, with 150 first year and 15 second year, the data for the five schools is given either as an overall mean, or in terms of the range of values, whichever seems the more appropriate. The range of upward means was from 28.32 to 31.78 for 36 items. That for downward was from 24.39 to 30.31, while that for simultaneous intervals was from 23.65 up to 28.78. Standard deviations ranged from 3.5 up to 7.8 yielding reliabilities with three over .90, two below .80, and with the remainder in the .80's. The summary of this data is shown in Table VIII.

Table VIII

Statistical Data for the Other Schools Summarized

Other Schools	N	Mode	Items	Mean of medians	Mean of means	Range of St. Dev.	Range of Reliability
Spring '77 1st yr.	150	up	36	30.4	29.95	3.5-6.0	.61 - .93
		down	36	28.2	28.5	4.2-7.8	.84 - .92
		sim's	36	26.1	24.81	5.9-7.1	.79 - .92
2nd yr.	15	up	36	34.2	32.39	4.20	.84
		down	36	32.0	30.36	5.13	.83
		sim's	36	31.0	28.77	7.10	.92

VIII. Confusion Analysis -- Other Schools

The error and confusion data for the 165 students from the five other schools was summarized and compared with the Set of 54 Confusions from the SUI first year class and also the Set of 30 Basic Confusions from the same class with the results shown in the table following. It is interesting to note that at the first year level 93% of the upward, 95% of the downward and 83% of the simultaneous interval errors and thus 89% of all the errors made were accounted for through common confusion patterns. The Set of 30 accounted for 75% upward, 73% downward and 64% simultaneous and 69% of the total number of errors made. On the second year level the class of 15 students achieved quite similar results. Concerning the Set of 54 Confusions 65% of the upward, 73% of the downward and 79% of the simultaneous for a total of 74% of all the errors were found to be common. Because of the small number of students the common ground with the Set of 30 Basic Confusions was not computed. It seems correct to suggest that the Set of 54 Confusions is inclusive enough of the various interval confusion problems to constitute a a suitable basis for the study of interval recognition aurally. The Set of

30 Basic Confusions provides a beginning for such study but is not comprehensive enough to be fully effective.

Table IX

Confusions and Errors - Sets of 54 and 30, Other Schools

	12 two-way - all 3 modes	12 two-way - not 3 modes	6 one-way - not 3 modes	Set of 54 confusions	11 two-way - all 3 modes	3 two-way - not 3 modes	2 one-way - not 3 modes	Basic set of 30 confusions
1st yr.* --	(Total errors = 712 -- UP)				--(Total errors = 712 -- UP)			
- Con's-	22	17	4	43	20	5	2	27
- Errors-	446	190	22	665	400	106	15	533
% of Total--	63%	26%	4%	93%	57%	15%	2%	75%
--	(Total errors= 1024 - DN.)				-- (Total errors = 1024)			
- Con's-	23	18	3	44	16	6	2	24
- Errors-	631	281	66	978	608	118	16	742
% of Total--	62%	27%	6%	95%	59%	13%	1%	73%
--	(Total errors= 1435 -- SIM.)				-- (Total errors = 1435)			
- Con's-	22	20	4	46	22	4	2	28
- Errors-	827	213	146	1186	816	33	68	917
% of Total--	58%	15%	10%	83%	57%	2%	5%	64%

* The total number of first year students was 150 from five schools, the samples including 18, 18, 29, 40, and 44.

2nd yr. -- The small class of 15 second year students is dealt with in the following manner:

- Upward intervals -- 32 confusions and 60 errors
  19 random confusions and 19 errors
  13 sig. confusions and 41 errors that accounted for 65% of all the errors made. There was one significant confusion with 2 errors (m7/P5) that was not in the Set of 54.
- Downward intervals - 32 confusions and 68 errors
  18 random confusions and 18 errors
  14 sig. confusions with 50 errors that accounted for 73% of all the errors made.
- Simultaneous intervals - 42 confusions and 90 errors
  15 random confusions and 15 errors
  25 sig. confusions with 71 errors that accounted for 79% of all errors made. There were two sig.

confusions with four errors (P8/P4; M6/P4) that were not in the Set of 54.

IX. Confusions and Quintiles - All Samples.

One result anticipated in this project was a determination of just when specific interval confusions became problems. Since intervals do differ in difficulty, is it possible that certain types of errors will tend to associate with certain levels of competency? This project has already shown that the Set of 54 Confusions of the SUI first year class has been able to account for about 75% to 95% of all interval errors made and this suggests that the other 78 possible interval confusions either had no errors or did not have enough to be considered significant problems.

The errors made by all the students involved in this project were organized by the quintile level at which they occurred and then summed to assign relative importance to each confusion in each of the three performance modes. In Table X all significant values of the 54 intervals confusions are listed in the order of their apparent difficulty as determined in the above manner.

Table X

54 Interval Confusions - by Overall Difficulty and Mode of Performance

Overall difficulty	Upward intervals	Downward intervals	Simultaneous intervals
1. M7/tt - 375	1. M7/tt - 104-2*	1. M7/m7 - 104-3	1. P4/P5 - 136-1
2. m7/M7 - 268	2. m6/tt - 72 -2	2. M7/tt - 104-2	2. m7/M7 - 106-1
3. m7/m6 - 246	3. m7/m6 - 64 -3	3. m2/M2 - 93 -2	3. m3/M3 - 92 -2
4. m2/M2 - 245	4. m6/m7 - 64 -3	4. m7/M7 - 92 -1	4. M7/tt - 90 -3
5. M3/m3 - 234	5. M7/m7 - 63 -2	5. m7/m6 - 80 -2	5. m6/P4 - 87 -2
6. M7/m7 - 230	6. m2/M2 - 56 -4	6. M3/m3 - 72 -3	6. m6/M3 - 86 -1
7. m3/M3 - 223	7. M7/m6 - 49 -2	7. M7/m6 - 65 -2	7. m6/M3 - 76 -2
8. P4/P5 - 217	8. m3/M3 - 48 -2	8. m3/M3 - 62 -3	8. tt/m7 - 73 -2
9. m6/M6 - 202	9. m6/M6 - 46 -1	9. m6/M6 - 60 -2	9. M2/m2 - 73 -2
10. m6/m7 - 174	10. tt/M7 - 42 -2	10. m6/m7 - 56 -2	10. P5/P4 - 67 -3
11. P5/P4 - 146	11. tt/m6 - 41 -3	11. tt/m6 - 52 -3	11. m6/M6 - 64 -3
12. tt/M7 - 144	12. m7/M7 - 40 -3	12. M6/m6 - 49 -2	12. m2/M2 - 63 -3
13. m7/tt - 142	13. P8/P5 - 39 -2	13. P5/M6 - 43 -2	13. m7/tt - 58 -2
14. M7/m6 - 134	14. M6/m6 - 39 -2	14. m7/tt - 41 -3	14. m7/m6 - 55 -2
15. M6/m6 - 134	15. tt/m7 - 39 -3	15. M6/tt - 41 -2	15. M7/m7 - 51 -3

Table X (continued)

Overall difficulty	Upward intervals	Downward intervals	Simultaneous intervals
16. M2/m2 - 128	16. P5/P4 - 33 -2	16.m7/M6 - 40 -2	16. tt/M7 - 49 -3
17. tt/m7 - 119	17. M3/m3 - 33 -2	17.P4/P5 - 40 -4	17. M6/M3 - 44 -2
18. tt/m6 - 112	18. M6/m7 - 31 -3	18.M7/M6 - 36 -3	18. M6/m6 - 38 -3
19. m6/P4 - 107	19. M3/P5 - 26 -4	19.tt/P4 - 36 -3	19. m6/P5 - 38 -4
20. P8/P5 - 96	20. m6/M7 - 24 -2	20.P4/tt - 36 -3	20. M3/M6 - 37 -3
21. m6/tt - 89	21. P4/P5 - 24 -3	21.P4/M3 - 36 -3	21. M3/P4 - 37 -3
22. M3/P5 - 89	22. m6/P5 - 22 -4	22.M2/m2 - 32 -3	22. m3/M6 - 33 -3
23. m3/M3 - 84	23. M6/M7 - 18 -3	23.P5/M3 - 29 -3	23. M3/P5 - 30 -4
24. M3/P4 - 76	24. M2/m3 - 18 -5	24.tt/m7 - 25 -2	24. m6/m3 - 28 -3
25. m7/M6 - 72	25. M2/M3 - 17 -5	25.P5/P4 - 24 -3	25. tt/m3 - 23 -3
26. M6/m7 - 71	26. m7/tt - 16 -2	26.M3/P5 - 24 -4	26. P4/M3 - 21 -4
27. M6/tt - 68	27. P5/m6 - 15 -4	27.M3/P4 - 24 -5	27. P8/P5 - 19 -4
28. P4/M3 - 68	28. m6/P4 - 14 -4	28.tt/M7 - 23 -2	28. m7/M6 - 18 -2
29. P5/M3 - 67	29. P5/M3 - 14 -5	29.tt/P5 - 23 -5	29. P5/M3 - 17 -5
30. m6/P5 - 66	30. tt/m3 - 13 -5	30.m6/M7 - 21 -4	30. M6/P5 - 16 -4
31. P5/M6 - 62	31. M3/P4 - 13 -5	31.P4/m3 - 20 -3	31. P5/M6 - 16 -4
32. tt/m3 - 53	32. M2/m2 - 12 -3	32 M6/m7 - 19 -3	32. m3/P4 - 16 -4
33. m6/M7 - 51	33. P4/M3 - 11 -4	33.m3/m6 - 19 -3	33. tt/P5 - 15 -3
34. M7/M6 - 50	34. M7/M6 - 9 -5	34.M6/M7 - 17 -3	34. m3/P5 - 15 -3
35. tt/P4 - 47	35. P4/m3 - 9 -5	35.M2/M3 - 17 -5	35. P4/m3 - 13 -4
36. tt/P5 - 46	36. tt/P5 - 8 -5	36.M2/m3 - 15 -4	36. M2/m3 - 13 -4
37. M2/m3 - 46	37. m3/P4 - 8 -5	37.P8/P5 - 14 -5	37. M6/tt - 12 -4
38. M6/M3 - 44	38. m7/M6 - 6 -4	38.m3/P4 - 14 -5	38. P5/m6 - 12 -4
39. P4/m3 - 42	39. m3/tt - 6 -5	39.M6/P5 - 12 -3	39. P5/P8 - 10 -3
40. M2/M3 - 40		40.P5/P8 - 8 -4	40. tt/m6 - 10 -3
41. M3/M6 - 38		41.P5/P8 - 8 -4	41. M6/m3 - 9 -5
42. m3/P4 - 38		42.m3/tt - 8 -5	42. m3/m6 - 9 -5
43. M6/M7 - 35		43.m6/tt - 7 -3	43. M7/m6 - 7 -3
44. m3/M6 - 33		44.M6/m3 - 6 -4	44. m6/m7 - 7 -5
45. m6/m3 - 32			45. m6/tt - 7 -3
46. m3/m6 - 32			46. M2/M3 - 6 -5
47. M6/P5 - 31			47. m3/tt - 5 -5
48. P5/m6 - 29			
49. M6/m3 - 26			
50. P5/P8 - 22			
51. m3/tt - 19			
52. m3/P5 - 17			
53. P4/tt - 4			
54. M3/m6 - 3			

All confusions with 4 errors or less were considered to be either non-significant or random.

* The number following the hyphen indicates the quintile level within which the particular confusion became significant.

X. Concerning Interval Difficulty Order - All Samples

Most aural skills teachers have given thought to the relative difficulty of intervals but the research literature in this area is thin. The Killam, et al, report[1] knowledgeably suggests that difficulty does not increase directly with increasing interval size, since for example, the perfect octave as the largest simple interval is almost always the easiest to recognize.

The present project indicates that interval difficulty may vary considerably for most intervals, but that, by and large, the twelve basic intervals show hierarchical tendencies based on their associated error counts.

Table XI

Interval Orders of Difficulty - All Modes, All Samples *

Upward		Downward		Simultaneous		Total	
m6 - 40.4% (errors)		m7 - 46.9		m6 - 54.9		m6 - 45.0	
M7 - 39.5		M7 - 45.2		m7 - 42.3	46%	M7 - 41.2	42%
m7 - 32.4	35%	M6 - 40.1	41%	M7 - 40.1		m7 - 40.5	
tt - 29.4		m6 - 39.8		M3 - 35.2		tt - 30.6	
M3 - 18.0		tt - 32.3		m3 - 32.2		M6 - 28.2	
M6 - 17.3		M3 - 22.1		tt - 32.1		M3 - 25.1	24%
P5 - 16.8	16%	m3 - 20.8		M6 - 27.3	29%	m3 - 22.9	
m3 - 15.9		m2 - 18.9	19%	P4 - 27.0		P5 - 19.6	
m2 - 14.7		P4 - 18.1		M2 - 26.6		P4 - 18.8	
P4 - 11.4		P5 - 16.2		P5 - 25.9		m2 - 17.6	
P8 - 9.2	10%	M2 - 14.1	10%	m2 - 20.3	17%	M2 - 16.2	15%
M2 - 8.0		P8 - 6.7		P8 - 13.5		P8 - 9.8	

Table XI shows that four intervals (m6,M7,m7 and tt) incurred an upward error burden which increased to 41% for five downward intervals (adding the M6) and grew further to 46% for three of the original four (less the tt) as simultaneous intervals. In the total column the tt mean was ten percentage points below the three highest intervals. On the low side, the P8, M2 and m2 gave a total mean error of 15%, but only the P8 was consistently low. In the melodic modes the m2 reached higher than expected levels and in the simultaneous mode the M2 was rather higher than the m2 in error. Note that the mean totals for the P4 and P5 are quite low with the P4 at the easy level in the upward mode, but more than twice as difficult in the simultaneous mode. Melodically the P5 showed a moderate error level but this was half again as high in the simultaneous mode. In the middle group the M6 was especially variable.

Another perspective becomes visible when the summed up, down, and simultaneous modes of the University of Iowa samples are compared with the same totals for the other schools and also for the Killam project, cited before.

In Table XII the stability of the m6,M7 and m7 is obvious with the tt somewhat more variable and less difficult. At the middle level the me proved to be consistent with the M3 and P5 more variable, while the P4 and M6 were especially variable. At the lowest level the P8 was consistent, but the seconds in the SUI sample were shifty.

Table XII.

Another Comparison of Interval Difficulty Orders - 3 Modes Summed

SUI-F,S	Other-F,S	Project-F,S	Killam, et al [1]
N - 448	N - 165	N - 613	N - 15
m6	m6	m6	m6
M7	M7	M7	m7
m7	m7	m7	M7
tt	M6	tt	tt
M3	tt	M6	m3
M6	M3	M3	M2
m3	m3	m3	M6
P5	P4	P5	P5
m2	P5	P4	P4
M2	m2	m2	m2
P4	M2	M2	M3
P8	P8	P8	P8

It is of special interest to note the interval order from the Killam et al report. The four most difficult intervals correspond nearly exactly and overall, therefore, eight. Three points are of interest in making this last comparison: (1) The Killam report involved 15 students, the current project, 613. (2) Each item in the Killam project was sounded either .1 or .2 seconds; in the current project each item sounded between 1 and 2 seconds. (3) In the Killam project each student responded in his own time; in the current project a new item was played each 15 seconds.

XI. Observations and Conclusions

The over-riding goal of this project was to provide information that could serve as guide lines for improving instruction for the aural identification of intervals. The following observations may, at the least, be of some interest, and can, at the most, perhaps be considered to hint

at a few interval hearing characteristics of the general music population of students.

1. Intervals vary in difficulty in the performance modes, but some general tendencies are apparent.
   a. The m6, M7, m7, and tt are the most consistently difficult.
   b. The P8 is easiest, with the m2 and M2 variably easy usually.
   c. In the middle group the m3 and P5 are the more consistent, and the M3 and M6 the most variable, with the P4 less variable.
2. Confusion patterns are also evident.
   a. Perhaps strangely, the M7/tt pattern has the most errors - 375.
   b. The m2 had only one significant confusion (m2/M2), but it had 245 errors.
   c. The P8 had but one such confusion (P8/P5) and this had 96 errors.
   d. The m6 was involved in 8 significant patterns, the tt and M6 had 7 and the m3 had 6 confusion patterns.
3. The individual intervals are important in particular performance modes.
   a. In the upward mode -- the m2.
   b. In the simultaneous mode -- the M2, P4 and P5.
   c. The M3 is important in both the downward and simultaneous modes.
   d. In all performance modes -- the m3, tt, m6, m7 and M7. The M8 and P8 are also important in all performance modes, but less so.

A student's proficiency changes in the course of training. By this token it seems reasonable that the student's functional ability to recognize intervals changes accordingly. In a practical sense this would change a student's quintile placement in interval hearing. Hence, it is thought that some listing of quintile levels and likely confusion problems could serve as guide lines for providing remedial training. Each quintile is considered in turn, briefly.

- Quintile 1. Almost no problems; most errors are random or hint at problems that arise in later quintiles.
- Quintile 2. In all modes -- confusions involving the m6, m7, M7 and tt.
  -- Upward - hints suggest m3 and M3 problems arising.
  -- Simult's - Problems with P4's and P5's begin.
- Quintile 3. In all modes -- the above, plus --
  -- Upward - hints suggesting m2 and M2 problems occur.
  -- Downward - adjacent interval confusions from the P4, up.
  -- Simult's - Problems with m2 and M2 begin.
- Quintile 4. In all modes -- the above, plus --
  -- Upward - small adjacent interval confusions occur.
  - tt confusions with small intervals occur.
  -- Downward - hints of P8 problems occur.
  - confusions involving 3rds and 5ths occur.
  -- Simult's - P8 problems begin.
- Quintile 5. In all modes -- the above, together with P8 problems in all modes.

A final hope is that this project will inspire more work in this and related areas concerning pitch perception to be accomplished with the end goal of improving student achievement.

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